Telemetry and Command Multiple-Mission Software (Model C)

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This article gives the status of the Deep Space Station Telemetry and Command operational software dedicated to the support of the Pioneer (10 and 11), Helios, Viking, and Extended Mariner Venus/Mercury missions. New application programs have been written and integrated with the existing executive. Model C retains the telemetry capabilities of Models A and B and utilizes the DSN Mark III-74 Command System (command redesign module). Additional functions have been added to support the Viking mission.

I. Introduction

Model C of the Telemetry and Command Subsystem (TCD) software has been implemented and will support JPL deep space missions through 1975. The multi-mission capability was accomplished by developing many specialized or mission-dependent program elements (data sets). Combinations of these data sets may be integrated to operate in a specific environment (TCD computers) and in a predetermined manner, e.g., control and monitor the Command Modulator Assembly (CMA) for command rate of 8 bits/s. The TCD computers used are the XDS 920 and the Interdata Model 4.

II. Major Categories and Support Software

The basic software categories (modules) are supervisor (executive), command telemetry, and 9-track Digital Original Data Record (DODR) replay. Each module usually consists of many data sets and must perform a dedicated function after integration:

(1) *Supervisor (EXEC).* This module performs the nonreal-time task of loading and link-editing all data sets required to do a specific job, viz., high-rate telemetry, low-rate telemetry, etc. EXEC also performs the real-time function of scheduling out-

bound high-speed data blocks, periodic transfers to monitor, DODR logging, local alarms, and initial processing of all input messages.

(2) *Command.* This module is dedicated to controlling and monitoring the CMA. Model C features one and only one mission-independent command element. Its capabilities are frequency-shift keying (FSK) tone at 1 bit/s, phase-shift keying (PSK)/pseudo-noise (PN) at 1 bit/s, coherent and noncoherent PSK at 8 bits/s maximum.

(3) *Telemetry.* Subsets from the inventory of telemetry routines are integrated in accordance with mission-related directives specified by the user. Newly acquired data are assembled by this module for transmission to the user in real time. Telemetry-related hardware assemblies are monitored and controlled and their status is recorded in Ground Communications Facility (GCF) images and monitor messages. Local alarms are generated whenever manual intervention is required. Model C telemetry capabilities are outlined in Table 1.

(4) *9-Track DODR Replay.* This module is considered to be a nonreal-time function and allows the user to selectively replay 9-track tapes logged by the high-rate telemetry channel. Present capabilities include time interval selection, user-dependent code type (UDT), and data-dependent code type (DDT) selections and the option to transmit over GCF lines at a fixed interval, viz., one block per second or at the line rate.

Support software has been developed (and improved) to perform the following functions:

(1) *Program Tape Maintenance.* A system was developed to delete, add, or alter data sets from the TCD system tape. The system tape is a 7-track digital magnetic tape written by the XDS 920 at a density of 200 bits/2.54 cm (200 bits/in.).

(2) *Punched Paper Tape and Edit Routine.* Prepares paper tape with input messages for subsequent processing by the (TCP resident) executive. The input messages are mission directives defining such variables as telemetry bit rate, format, command format, configuration(s), and so forth.

(3) *Bootstrap Loader.* Bootload (on punched paper tape) loads controller (EXEC) from the system tape.

III. Real-Time Operation

After a collection of data sets has been loaded by the supervisor, the newly loaded software becomes an interrupt-driven system with a priority subprogram queue (PSQ) structure. The executive monitors the PSQ and will transfer control to a specific subprogram as a result of a real-time event. This event may be an interrupt or a directive in the form of a manual input message.

IV. Mission-Dependent Data Sets

The software was implemented by developing mission-oriented segments and integrating with a basic nucleus. Each project has been provided with a set of input directives which the operator can use to select specific subsets of routines. Corresponding to each configuration directive is a "configuration list" which is processed by the executive. Each mission has its own data base containing parameters such as the bit rate for high-rate telemetry, abort return address in the command module, etc. Each mission also has its own GCF block formatter in order to meet the DSN/MCCC interface requirements (820-13).

V. Summary

Mission-dependent routines (data sets) may be specified in the configuration table portion of the supervisor. New application programs have been written and integrated with the existing executive. Model A has been used successfully as a flight support instrument for MVM'73. Model B was released with Command System redesign and software central to the support of the Pioneer and Helios Projects. Model B has undergone extensive acceptance testing and successful compatibility testing with the Helios spacecraft. Model C, which is being released, retains the telemetry capabilities of Models A and B plus the command redesign module. Additional functions have been added in order to support the Viking mission, and Model C is now in the final stages of acceptance testing.

Table 1. Telemetry capabilities

TCD computer	Function	Mission and bit rate constraints
XDS 920	Low-rate bit synchronization	MVM'73, Viking 8.33, 33.33 bits/s
ID4, XDS 920	Medium-rate block decoding	MVM'73, Viking 250, 490, 500, 1000, 2000, 2450 bits/s
ID4, XDS 920	Processing of medium- (low-) rate uncoded data	MVM'73, Viking 8.333, 33.333, 250, 500, 1000, 2000 bits/s
ID4, XDS 920	Sequential decoding (192, 384-bit frames) and processing of uncoded data	Pioneer 8 16, 32, 64, 128, 256, 512, 1024, 2048 bits/s
ID4, XDS 920	Sequential decoding (1152-bit frames)	HELIOS Bit rates same as Pioneer
ID4, XDS 920	Processing of uncoded data for Helios	HELIOS Bit rates same as Pioneer
ID4, XDS 920	Processing of high-rate block decoded or uncoded data	MVM'73, Viking Coded: all MVM and Viking rates Uncoded: 250, 500, 1000, 2000, 4000, 8000, 1176000 bits/s